

## C4193 Log Data Report

### Borehole Information:

<b>Borehole:</b> C4193			<b>Site:</b> 216-B-26 Trench		
<b>Coordinates</b> (WA State Plane)		<b>GWL (ft)<sup>1</sup>:</b>	Not reached	<b>GWL Date:</b>	11/13/2003
<b>North</b> n/a <sup>3</sup>	<b>East</b> n/a	<b>Drill Date</b> Nov. 2003	<b>TOC<sup>2</sup> Elevation</b> n/a	<b>Total Depth (ft)</b> 40	<b>Type</b> Percussion

### Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	0	6 5/8	5 5/8	1/2	0	
The logging engineer used a caliper to determine the outside casing diameter. The caliper and inside casing diameter were measured using a steel tape. Measurements were rounded to the nearest 1/16 in. Casing thickness was calculated.						

### Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drill pipe. The ground surface between 0 and about 1 ft is compacted gravel that was trucked in to stabilize the ground surface for drilling and logging operations.

### Logging Equipment Information:

<b>Logging System:</b>	Gamma 2A	<b>Type:</b>	35% HPGe (34-TP20863A)
<b>Calibration Date:</b>	09/2002	<b>Calibration Reference:</b>	GJO-2002-383-TAC
	<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0		

<b>Logging System:</b>	Gamma 1C	<b>Type:</b>	High Rate Detector
<b>Calibration Date:</b>	04/2003	<b>Calibration Reference:</b>	GJO-2003-429-TAC
	<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0		

<b>Logging System:</b>	Gamma 2F	<b>Type:</b>	Moisture (H380932510)
<b>Calibration Date:</b>	09/2003	<b>Calibration Reference:</b>	GJO-2003-520-TAC
	<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0		

### Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2/Repeat			
Date	11/13/03	11/13/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	38.0	5.0			

<b>Log Run</b>	<b>1</b>	<b>2/Repeat</b>			
Finish Depth (ft)	0	1.0			
Count Time (sec)	200	200			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A <sup>4</sup>	N/A			
Pre-Verification	BA215CAB	BA215CAB			
Start File	BA216000	BA216038			
Finish File	BA216037	BA216042			
Post-Verification	BA216CAA	BA216CAA			
Depth Return Error (in.)	1 ft	0			
Comments	Fine-gain adjustment before logging began and after file -016.	Repeat section.			

### **High Rate Logging System (HRLS) Log Run Information:**

<b>Log Run</b>	<b>1</b>	<b>2/Repeat</b>			
Date	11/25/03	11/25/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	16.0	13.0			
Finish Depth (ft)	9.0	11.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A	N/A			
Pre-Verification	AC081CAB	AC081CAB			
Start File	AC083000	AC083008			
Finish File	AC083007	AC083010			
Post-Verification	AC083CAA	AC083CAA			
Depth Return Error (in.)	N/A	0			
Comments	No fine-gain adjustment.	Repeat section.			

### **Neutron Moisture Logging System (NMLS) Log Run Information:**

<b>Log Run</b>	<b>1</b>	<b>2/Repeat</b>			
Date	11/13/03	11/13/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0	11.0			
Finish Depth (ft)	39.5	15.0			
Count Time (sec)	N/A	N/A			
Live/Real	R	R			
Shield (Y/N)	N/A	N/A			
MSA Interval (ft)	0.25	0.25			
ft/min	1.0	1.0			
Pre-Verification	BF112CAB	BF112CAB			
Start File	BF112000	BF112159			

Log Run	1	2/Repeat			
Finish File	BF112158	BF112175			
Post-Verification	BF112CAA	BF112CAA			
Depth Return Error (in.)	N/A	0			
Comments	None	Repeat section.			

### **Logging Operation Notes:**

Zero reference was the ground surface, and the borehole was logged through drill pipe. Logging was performed with a centralizer installed on the sondes.

SGLS data were collected using Gamma 2A. Pre- and post-survey verification measurements employed the Amersham KUT ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ) verifier with serial number 082. To correct for the depth return error, 1.0 ft should be added to the reported depths for data files numbered BA216000 through BA216037.

HRLS data were collected using Gamma 1C. Pre- and post-survey verification measurements employed the  $^{137}\text{Cs}$  verifier with serial number 1013.

### **Analysis Notes:**

<b>Analyst:</b>	Sobczyk	<b>Date:</b>	12/01/03	<b>Reference:</b>	GJO-HGLP 1.6.3, Rev. 0
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SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits. All of the verification spectra were outside the acceptance criteria. The photopeak counts per second (cps) at 2614.5 keV for the pre-run and post-run spectra were below the acceptance criteria. Examinations of spectra indicate that the recorded peak counts per second have slightly reduced calculated concentrations above 1500 keV, and the spectra are provisionally accepted.

HRLS pre-run and post-run verification spectra were collected at the beginning and end of the day. The spectra were within the acceptance criteria for the field verification of the Gamma 1C logging system (HRLS).

NMLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits established on 12/05/2002. The post-run verification spectrum was within the control limits while the pre-run verification spectrum recorded 738 cps versus the upper control limit of 735 cps.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G2AFeb03.xls [SGLS] and G1CApr03.xls [HRLS]). Zero reference was the ground surface. To correct for the depth return error, 1.0 ft was added to the reported depths for data files numbered BA216000 through BA216037 (log run 1). On the basis of measurements supplied by the driller, the casing configuration was assumed to be one string of 6-in. casing to total logging depth (39 ft). The SGLS and HRLS casing correction factors were calculated using a 6-in. casing thickness of 0.5 in. This casing thickness is based upon the field measurement. A water correction was not required.

Using the SGLS, dead time greater than 40 percent was encountered in the interval from 10 to 15 ft, and data from this region are considered unreliable. At SGLS dead time greater than 40 percent, peak spreading and pulse pile-up effects may result in underestimation of activities. This effect is not entirely corrected by the dead time correction, and the extent of error increases with increasing dead time. SGLS dead time corrections were applied when dead time surpassed 10.5 percent. The HRLS was utilized to obtain data where the SGLS dead time exceeded 40 percent.

NMLS log spectra were processed in batch mode using APTEC SUPERVISOR to determine count rates. The volume fraction of water was calculated in EXCEL, using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. The neutron moisture calibration is based on a typical 6-in. casing with a thickness of 0.28 in., and the neutron moisture values were corrected for the 0.5-in. casing thickness.

### **Log Plot Notes:**

Separate log plots are provided for gross gamma and dead time, gross gamma and volume fraction of water, naturally occurring radionuclides ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The  $^{214}\text{Bi}$  peak at 1764 keV was used to determine the naturally occurring  $^{238}\text{U}$  concentrations on the combination plot rather than the  $^{214}\text{Bi}$  peak at 609 keV because it exhibited slightly higher net counts per second.

### **Results and Interpretations:**

$^{137}\text{Cs}$  and  $^{125}\text{Sb}$  were the man-made radionuclides detected in this borehole.  $^{137}\text{Cs}$  was essentially detected throughout the entire length of the borehole at concentrations ranging from the MDL (0.2 pCi/g) to 385,000 pCi/g. The maximum concentration of  $^{137}\text{Cs}$  was measured at 14 ft.  $^{125}\text{Sb}$  was detected at 19 ft with a concentration of 1.6 pCi/g.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS, SGLS, and NMLS data.  $^{137}\text{Cs}$  (662 keV) concentrations are comparable between the repeat and original HRLS log runs.  $^{137}\text{Cs}$  and the natural radionuclides at energy levels of 662, 609, 1461, 1764, and 2614 keV are comparable between the repeat and original SGLS log runs. The neutron-moisture and its repeat are within the acceptance criteria.

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<sup>1</sup> GWL – groundwater level

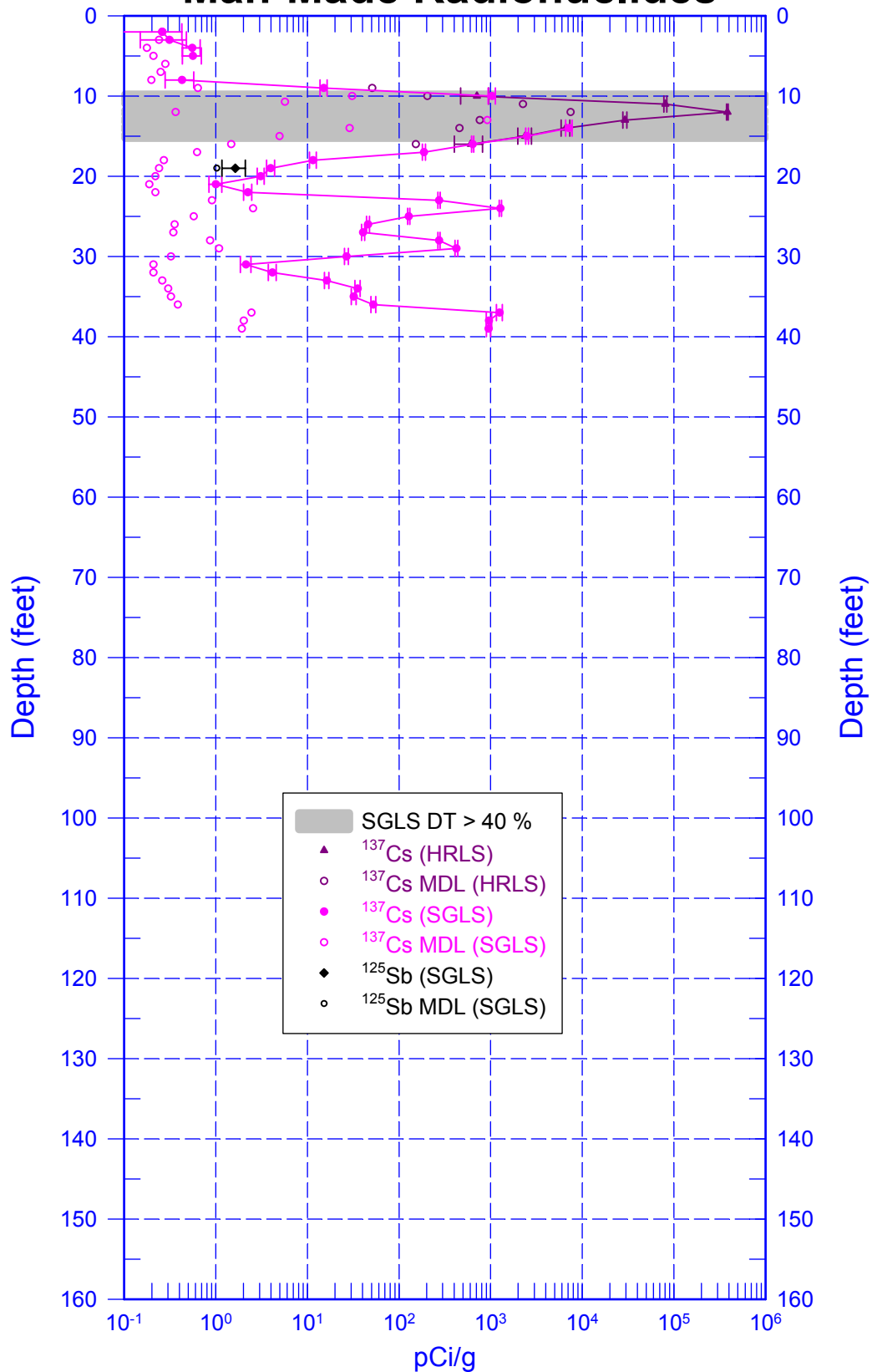
<sup>2</sup> TOC – top of casing

<sup>3</sup> n/a – not available

<sup>4</sup> N/A – not applicable

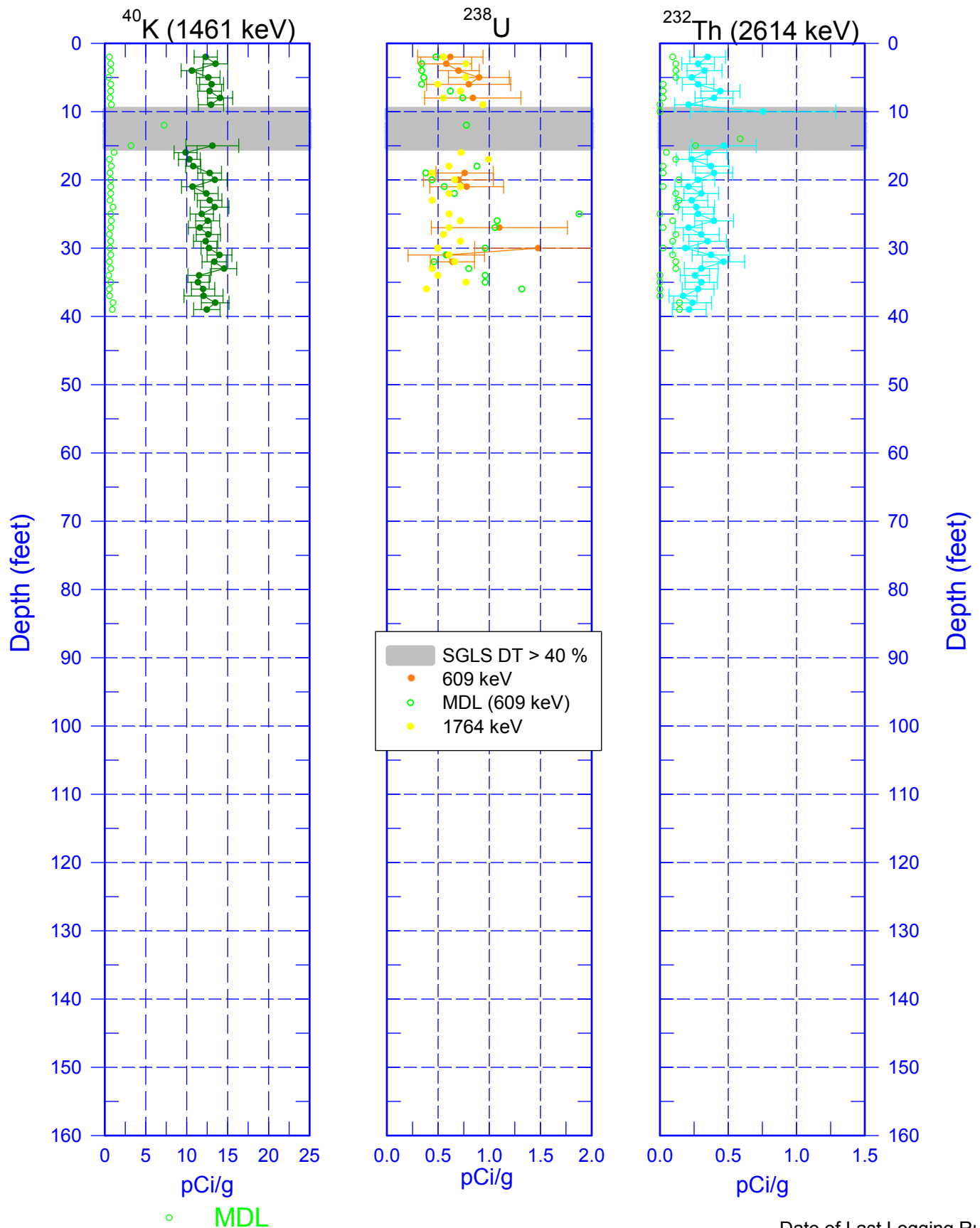
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## Man-Made Radionuclides



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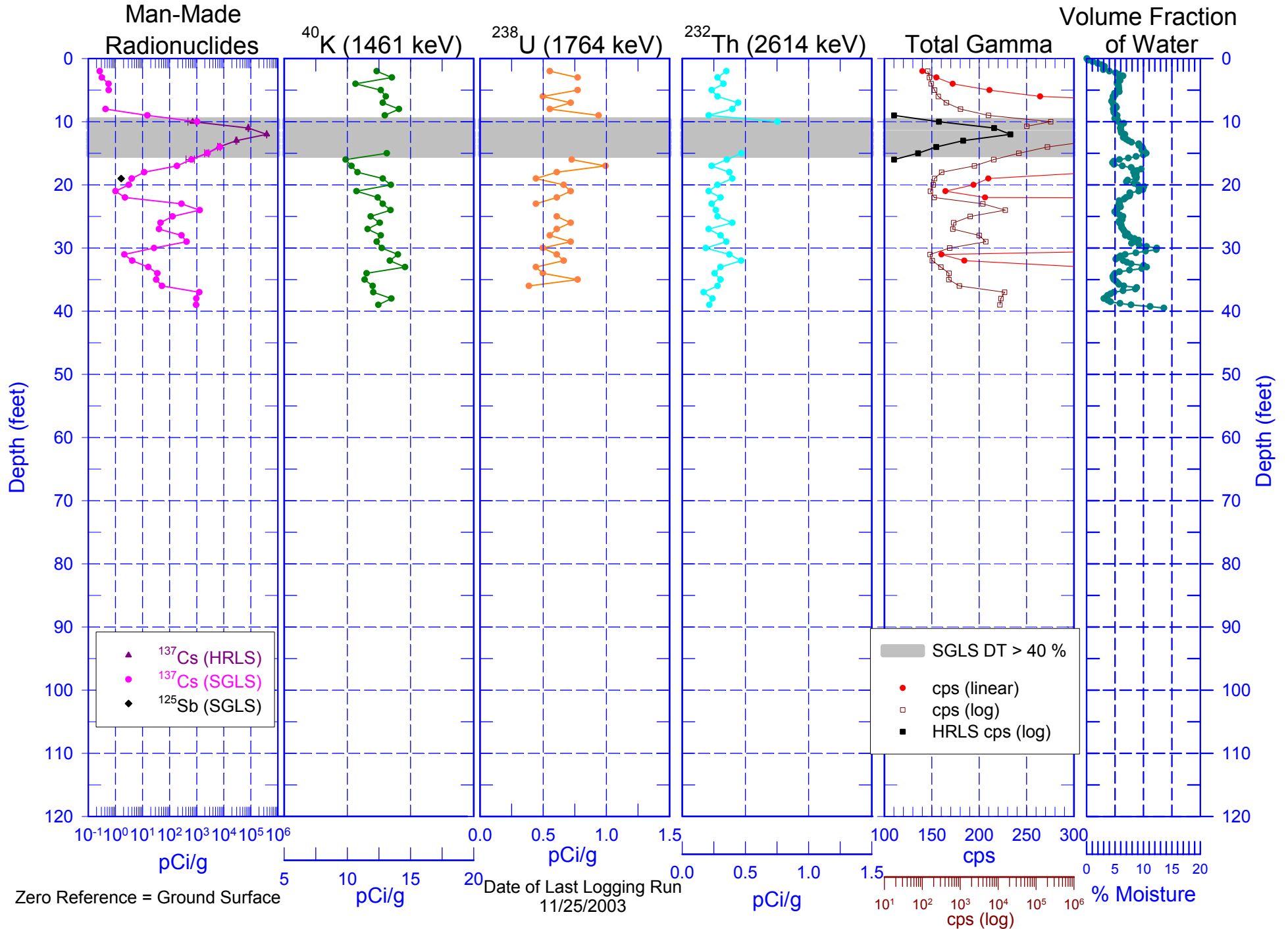
## Natural Gamma Logs



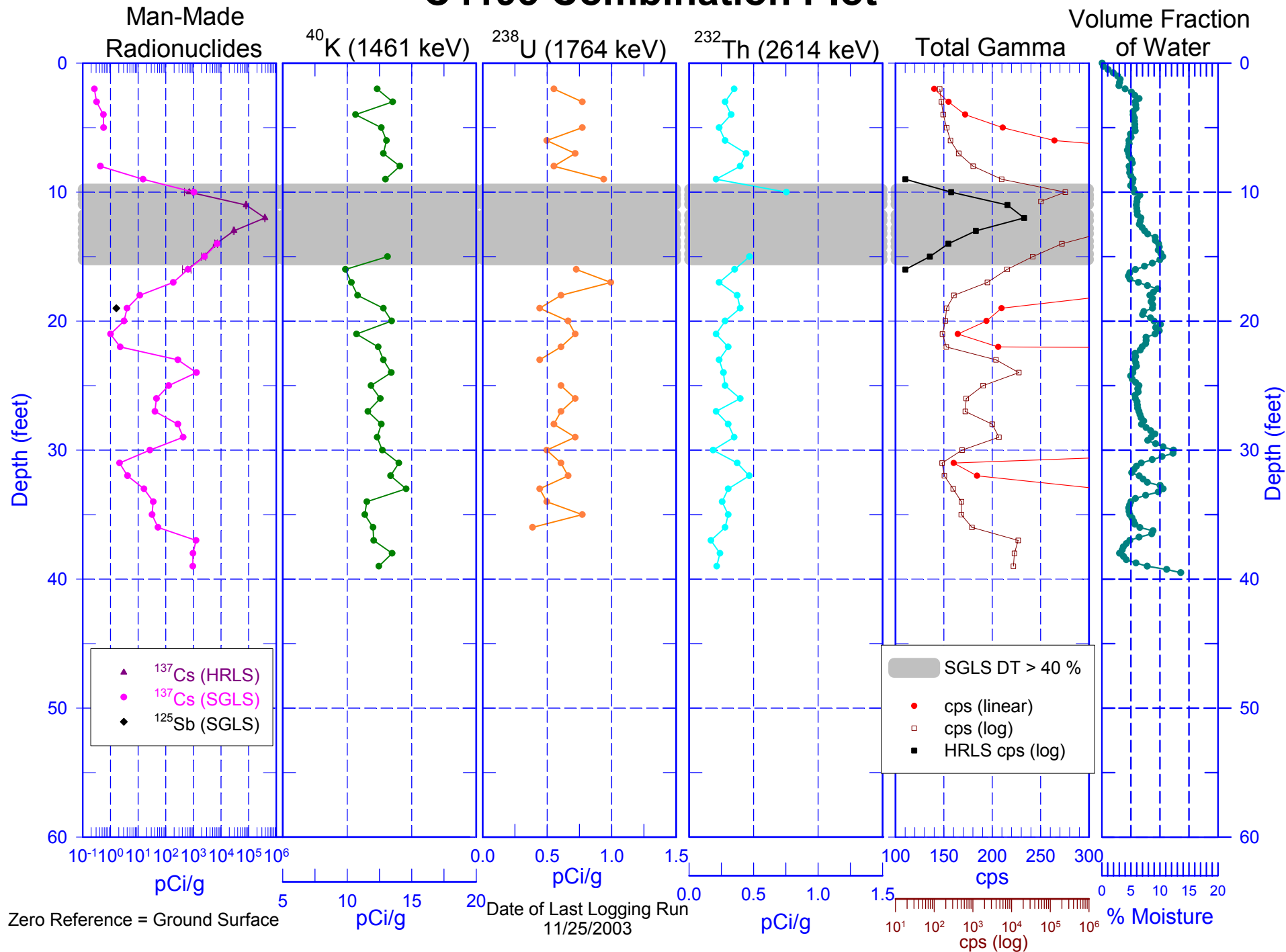
Zero Reference = Ground Surface

Date of Last Logging Run  
11/13/2003

# C4193 Combination Plot



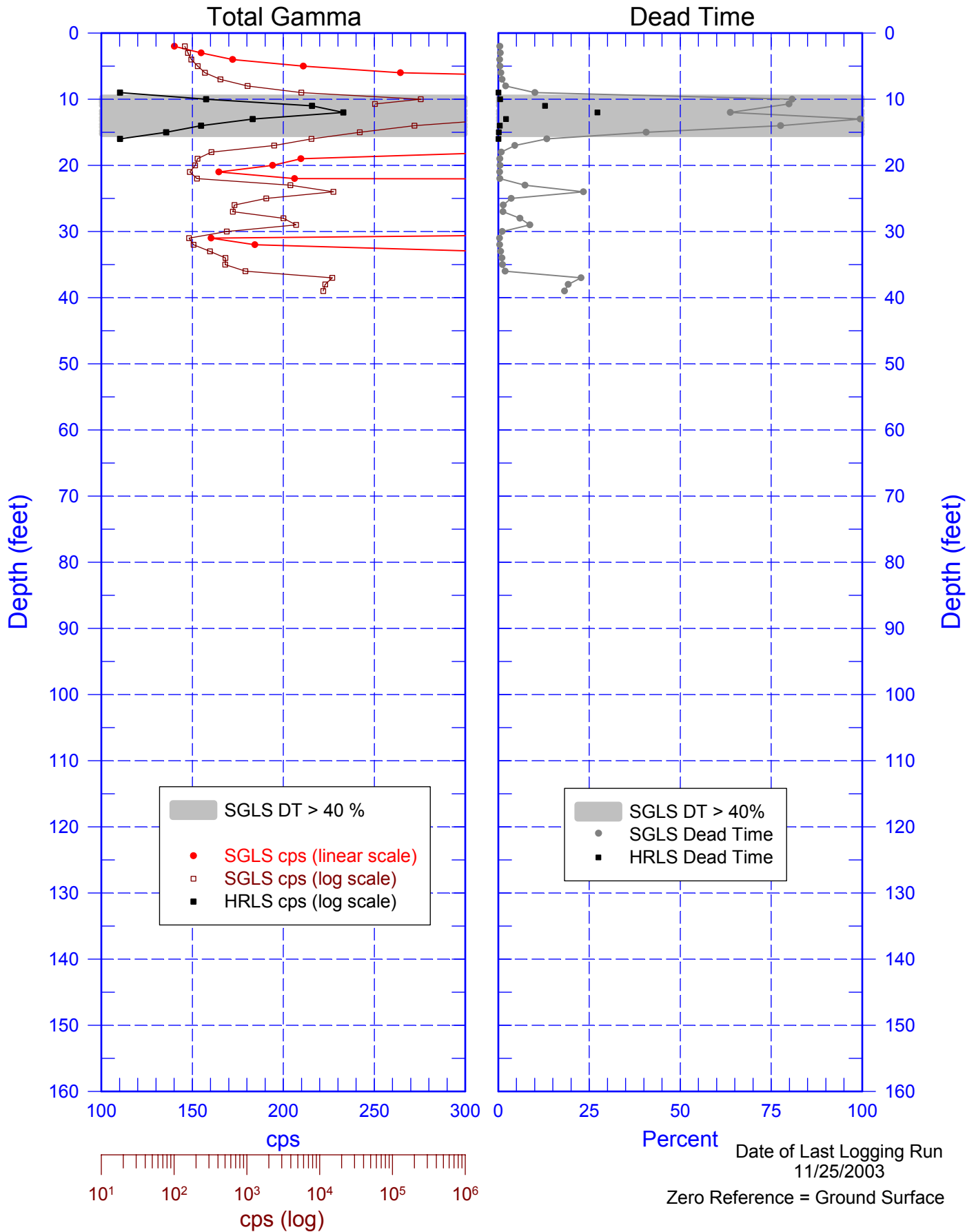
# C4193 Combination Plot





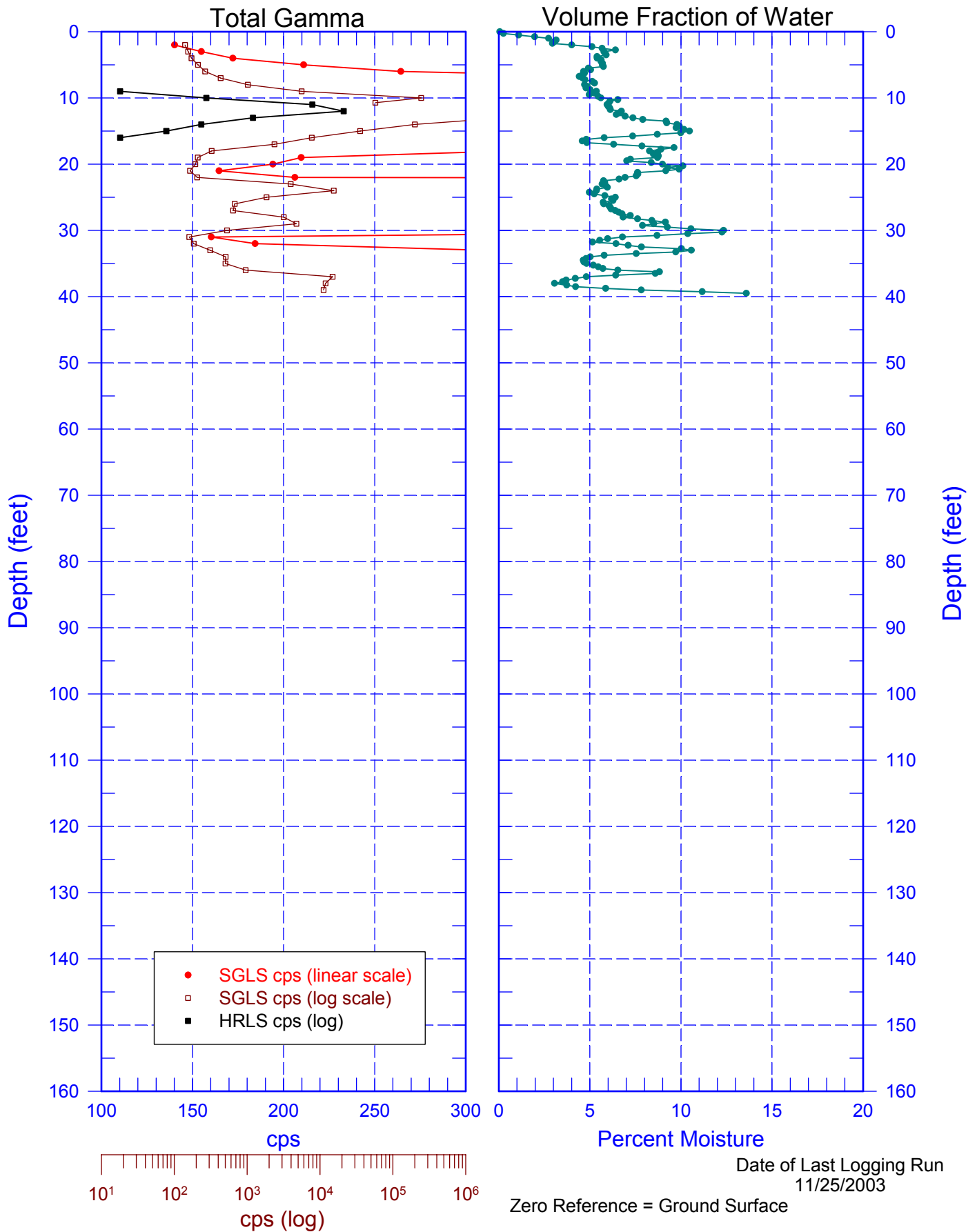
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## Total Gamma & Dead Time



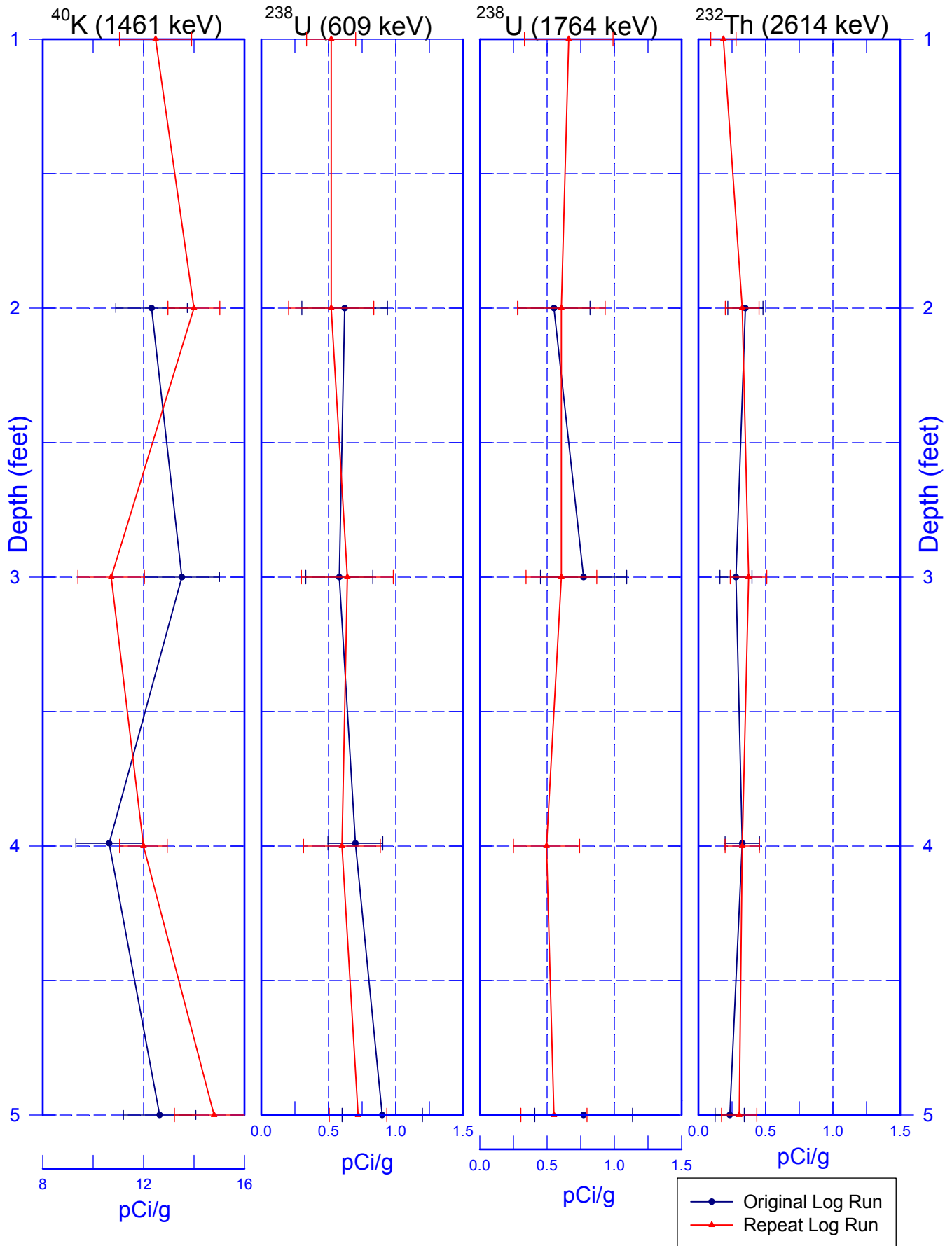
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## Total Gamma & Neutron



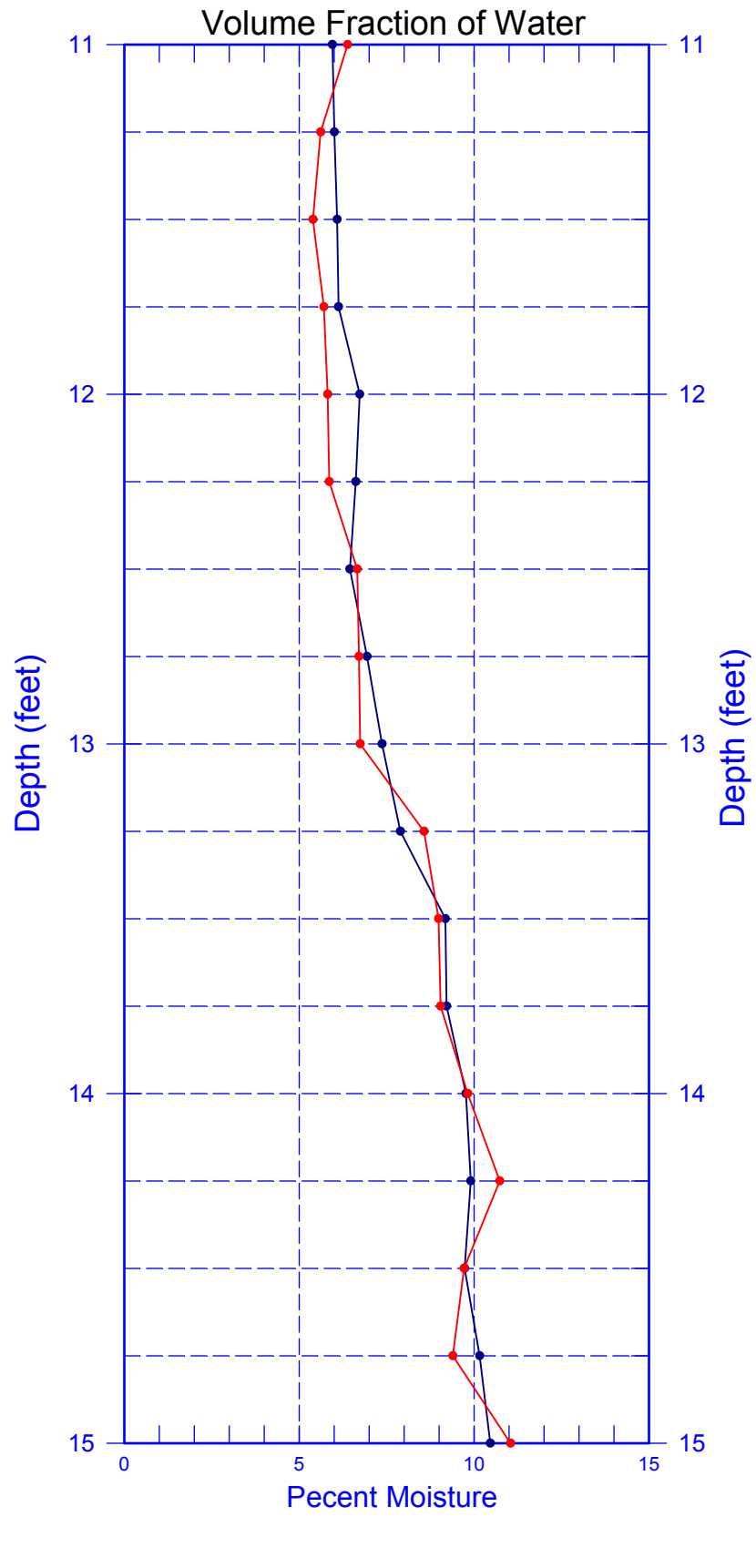
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## Rerun of Natural Gamma Logs (5.0 to 1.0 ft)



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## Rerun of Neutron-Moisture Log (11.0 to 15.0 ft)



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## Rerun of Man-Made Radionuclides

